Post-combustion CO_2 capture from flue gases emitted by fossil fuel-fired power plants

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Keywords: CO_2 capture, hybrid energy storage, circular economy, renewable energy, membrane separation
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The present study is part of a circular economy programme (LIFE "CO_2toCH_4"), which aims to develop and demonstrate an innovative, integrated and sustainable industrial process for the simultaneous energy storage and CO_2 Capture and Utilization (CCU). The principal idea of LIFE CO_2toCH_4 involves the construction, operation and demonstration of an autonomous mobile unit for hybrid energy storage, which uses the exhaust gases from a thermo-electric power plant (burning lignite), as well as hydrogen (H_2) produced from water electrolysis (by using renewable energy sources) and subsequently, converts them into (bio)methane (CH_4), i.e., into an alternative energy source.
The mobile unit consists of three fundamental sub-units: (i) the electrolyzer (for the production of H_2), (ii) the exhaust waste gases cleaning/purification system, and (iii) the bio-methanation unit. Before the main implementation actions, which include the operation, optimization and demonstration of the prototype mobile unit, a detailed technical preparation design of the integrated process elements (i.e., electrolyzer, cleaning system, bio-methane reactor) was conducted. The present work describes the general operation of the prototype system and primarily focuses on the separation of CO_2 with a two-stage polyimide membrane system, providing also an overview of the most significant post-combustion CO_2 capture processes.

Table 1. Composition of flue gases from the thermo-electric power plant.

Substance	*Mean value*
SO_2	208 mg/Nm^3
NO_x	231.9 mg/Nm^3
CO	72.6 mg/Nm^3
Dust	22.5 mg/Nm^3
CO_2	11.3 %
O_2	7.8 %
H_2O	20.8 %

Acknowledgements

The "Demonstration of a mobile unit for hybrid energy storage based on CO_2 capture and renewable energy sources (LIFE CO_2toCH_4)" project has received funding from the LIFE Programme of the European Union.